The present invention is related to an optical fiber strain sensor device 5 (using, as an example, Figure 2) that includes an FBG sensor 6 and a filter 9, wherein by using the filter 9, the optical fiber strain sensor device 5 processes a change in the center wavelength of the light ray that is incident from the broadband light source 11 and then reflected from the FBG sensor 6. Using the device of the present invention, strain change of a structural body such as a bridge, building, aircraft, etc., can be measured optically rather than electronically. Accordingly, the present invention is free from the effects of electromagnetic interference found when measuring strain electronically, such as by a piezoelectric technique.

The Examiner states that the present invention, as claimed, is disclosed by the combination of Peupelmann in view of Johnson et al. Applicants respectfully traverse this rejection.

In the present invention, measurement of strain is intended for detection of a small rapid change in strain such as one caused by an ultrasonic wave. The response waveforms shown in Figures 7 and 9 of the present application are responses to ultrasonic waves. Since an ultrasonic wave is a kind of small rapid change in strain, detection for measurement of strain using an FBG sensor can be performed on the same principle.

The patents to Peupelmann and Johnson are techniques relating to measurement of a large strain accompanied by a deformation and cannot be applied to measurement of a strain caused by an ultrasonic wave, such as that measured by the technique in accordance with the present application. For ultrasonic measurement, it is required to use a filter of which optical characteristic changes in a restricted wavelength region as shown in Figure 6. A combination of

the intensity of light reflected from the filter and the intensity of light transmitted through the filter can provide an ultrasonic response with high fidelity to the original waveform. The present invention relates to a technique for detecting a small strain at a high frequency (for example, 20 kHz or higher), such as the emission of an ultrasonic wave or an elastic wave, and would not be disclosed or suggested by the combination of the patents to Peupelmann and Johnson.

<u>Peupelmann</u>

Turning to Peupelmann, the Examiner states that this reference discloses the invention as claimed in independent claims 1 and 8, except for the feature of detecting a strain by detecting a change in a center wavelength of the light ray reflected by the FBG sensor. In the present invention, a filter, for example a bandpass filter such as shown in Figure 4 of the present application is used to measure a change in strain caused by fine ultrasonic vibration.

The filter used in the device disclosed in Peupelmann is an edge filter having such a characteristic that the transmittance and reflectance change in proportion to the wavelength. An edge filter is a type of filter whose optical characteristic (reflectance or transmittance) increases or decreases monotonously with the wavelength. A change in strain caused by an ultrasonic wave or an elastic wave is very small.

In a case where an ultrasonic wave or an elastic wave is detected through an FBG sensor when a wide-range light source is used, it is required to use a filter having substantially the same wavelength region as that of the FBG sensor, i.e., the wavelength region in which the transmittance and the reflectance change. Edge filters presently available have wide wavelength regions in which the optical characteristics change, and are incapable of detecting small vibration

such as an ultrasonic wave. The filters used in the present application, may be, for example, various available bandpass filters having wavelength regions from several ten picometers to several ten nanometers. An edge filter would not be used to detect a strain such as an ultrasonic wave or an elastic wave.

An FBG has a bandpass filter function and can therefore be used both as a sensor and as a filter. If an FBG is used as a sensor and as a filter, a measuring system constituted by an optical fiber can be constructed as a small system having improved durability. Thus, Peupelmann relates to a technique relating to measurement of large strain. It is different from the technique of the present application that is directed to detection of the emission of an ultrasonic wave or an elastic wave.

Johnson et al.

Applicants respectfully submit that Johnson et al. also does not disclose using a filter to detect a strain by detecting a change in a center wavelength of the light ray reflected by the FBG sensor. While Johnson et al. is related to an optical sensing device containing fiber Bragg gratings, there is no suggestion of the aforementioned feature. The Examiner alleges that this feature is disclosed at col. 3, lines 25-30 of Johnson et al.

With the device disclosed in Johnson et al., the Bragg wavelength of an FBG sensor is measured in such a manner that a change in the Bragg wavelength of the FBG sensor is converted into a change in phase by an interferometer and the phase information signal undergoes modulation processing. The device of Johnson is a system in which a wavelength, at which the intensity of reflected light is maximized, is detected from the operating wavelength of

a scanning-type Fabry-Perot filter (corresponding to "328" in the Figure at the bottom of the cover of the document for the patent to Johnson), and the measuring sampling rate is the same as the sampling rate of the filter. That is, the device is capable of measurement of strain at a sampling rate at or lower than 10 kHz, but incapable of detecting a rapid change in strain caused by an ultrasonic wave, e.g., the change in strain mentioned in the specification of the present application with respect to the embodiment shown in FIG. 7 (at a sampling rate of 100 MHz). The operating frequency of the scanning-type Fabry-Perot filter used in the device taught Johnson is 10 kHz at the highest and the device is incapable of detecting an ultrasonic wave exceeding 20 kHz. Thus, the device of Johnson is totally different in technical features from the the present invention. Accordingly, one of ordinary skill in the art would not be motivated to combine Peupelmann and Johnson. Thus, Applicants respectfully submit that claims 1 and 8, as well as claims 3-5 dependent on claim 1 are allowable.

Similarly, because of the different types of filtering disclosed in Johnson et al., the transmission and reflection features of independent claims 2 and 9 would not be suggested, particularly with respect to detecting an amplitude change, and adding the inverted and non-inverted signals to each other.

In addition, the Examiner acknowledges that Peupelmann does not disclose detecting an amplitude change by inverting the phase of the signal (see page 3 of the Office Action) as recited in claim 2 and similarly in claim 9. As such, this inherently indicates that adding the inverted and non-inverted signals together is also not disclosed in the cited art. The Examiner does not address how this addition or summing feature is suggested.

Further, the Examiner's statement with respect to the aforementioned "missing" features of claims 2 and 9 that it would have been obvious to modify Peupelmann's system with a different method to use the system in different environments is vague and does not support a prima facie case of obviousness. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." Ex parte Clapp, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985). Merely concluding that it would have been obvious without discussing how the cited art would lead to this conclusion is improper.

Claims 3 and 4 stand rejected under 35 U.S.C. § 103(a) as being unpatenable over Peupelmann in view of Johnson et al., and further in view of Bennion et al. (U.S. Patent No. 6,018,160). Claims 3 and 4 are at least allowable based on their dependence on claim 1 for the reasons discussed above. Further, claims 3 and 4 each recite an optical circulator feature. The Examiner states that it would have been obvious to include Bennion's optical circulator with Peupelmann's device to separate the reflected light more efficiently (reason provided for claim 3) or to enhance the result (reason provided for claim 4). Again, Applicants respectfully submit that the Examiner has not discussed how the cited art would lead to this conclusion. Therefore, the Examiner is kindly requested to allow these claims, or more fully explain how the references teach the alleged combination.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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